Soil color: An inexpensive yet effective method for documenting soil carbon content

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Soil carbon sequestration is an oft-cited potential "green benefit" of biomass production. Yet accurately ascertaining soil carbon content within and across fields is difficult because of soil variability and the differential impact of various field management schemes ?see 1, 2?. In addition, direct measurements of soil carbon tend to be time-consuming and expensive ?1?. Thus, there is a tremendous need for an effective methodology that can inexpensively predict soil carbon contents. Without such a method it is possible that the costs of soil carbon sequestration verification may simply exceed its economic value.

The objective of this paper is to evaluate whether soil color is a suitable proxy for soil carbon content. The rationale behind this approach is the well-known relationship between soil carbon content and soil color. For example, some researchers have found the correlation between these two properties being as high as 0.9 ?3?. The experimental approach involved sampling 212 pedons from across the Chariton River Valley in south-central Iowa. Each pedon was collected as a core extending 1 m deep into the soil. Each pedon was described and divided into 5 to 8 horizons. Each horizon (total number ?1300) was analyzed for soil organic carbon content and soil color using both a standard Munsell color book and a chromameter. Color parameters measured are hue, value, and chroma. Each sample color analysis took well less than 1 minute. All pedons came from an ongoing soil carbon sequestration project wherein carbon contents are being compared between fields having six different land uses.

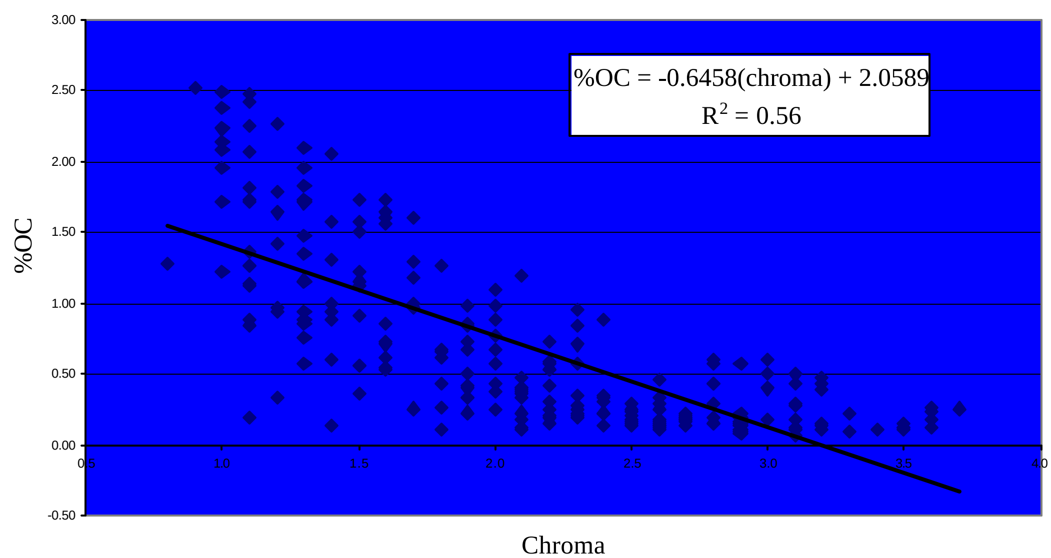

Figure 1: Relationship between organic carbon content and soil chroma, measured using a chromameter, for a representative subsample of horizons, Chariton River Valley, Iowa.

Plotting soil chroma or soil value against soil carbon content shows a near linear relationship (e.g., Figure 1). Using multiple linear regression to obtain a best-fit line for soil organic carbon content (%OC) and chromameter value and chroma results in equation 1:

Equation 1: $\%OC = 4.204 - 0.536(\text{value}) - 0.332(\text{chroma})$, $r^2 = 0.67^{**}$, $n = 225$

This relationship is similar to the one reported by others in the central USA. It is expected this relationship will improve when the other 1000+ horizons are included, especially once they are partitioned into two sub-populations: (a) epipedons, and (b) subsurface horizons. It is thought that partitioning will be beneficial because soil color in the epipedon derives primarily from soil organic matter content while soil color in lower horizons derives from mineral pigmentation ?3?.

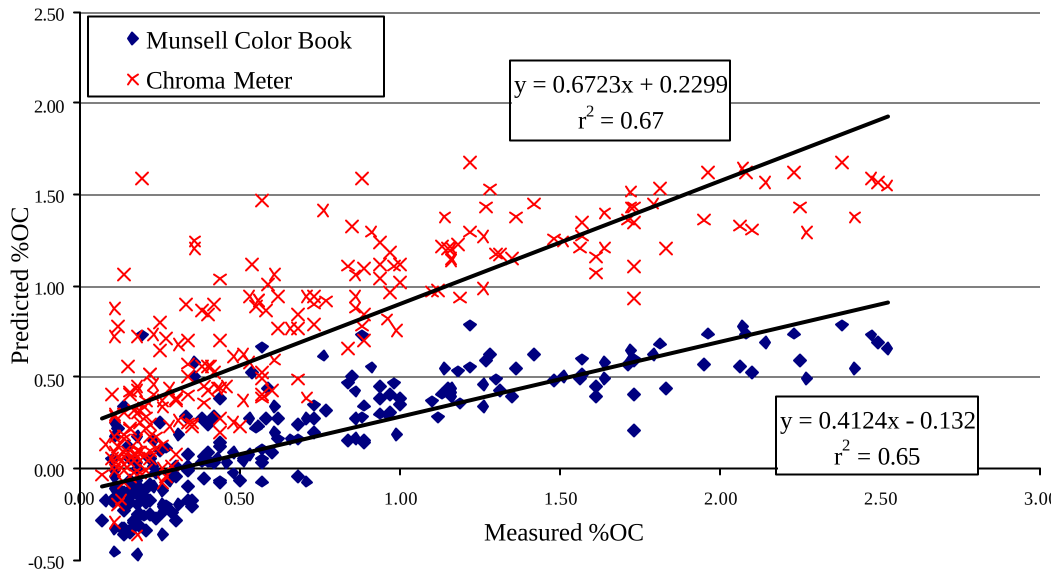

Figure 2: Plots of measured versus predicted soil carbon contents in the Chariton River Valley, Iowa.

Figure 2 suggests significant potential exists for successfully predicting soil carbon content simply by measuring soil color, either with a Munsell color book or with a chromameter, and then using that data in an appropriate linear regression equation (e.g., equation 1). If this is true, then soil color will serve as a quick proxy for ascertaining soil carbon content. Furthermore, in settings where a great number of measurements are necessary, the cost and speed of using a Munsell color book (cost ? $100) or chromameter (cost ? $10,000) would make this approach very suitable for soil carbon verification.

References listed

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